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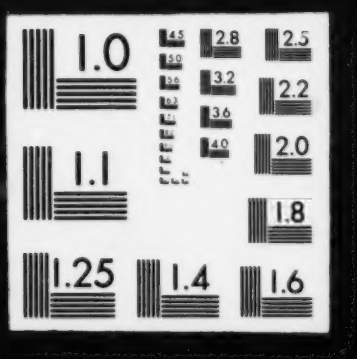

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Leslie A. Chambers, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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AIR POLLUTION CONTROL RESEARCH AT THE ROBERT A. TAFT SANITARY ENGINEERING CENTER

by

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Materials inimical to human and other forms of life have been among the components of the earth's atmosphere since before life existed. Natural phenomena - wind, volcanos, forest fires, and vegetation cycles, - undoubtedly produce a much greater total mass of air contaminants than the sum of the discharges from man's communal and industrial activity. Some of these pollutants the race has learned through catastrophic experience to avoid; some we have accepted as tolerable through undefined adaptive processes; while others, for example the pollens, are still very much within the consciousness of the species.

But within historic times the interpolation of human populations into the environmental system has begun to have its ponderable effects. In very recent years the airborne effluvia resulting from man's own activities have emerged as nuisances, causes of severe economic loss, contributors to discomfort, and occasionally, as killers. Most recent of the recognized lethal episodes was that in London in December of 1952 where more than 4,000 persons died in a week as the direct result of an accumulation of pollutants in a static air mass over the city. One may suspect that less obtrusive increments in mortality or morbidity are

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occurring in many places; their recognition would be improbable in the absence of mechanisms for correlation of vital data with pollutional variables.

The most obvious manifestation of air pollution is associated with the burning of smoke producing fuels. Soiling of clothing, buildings, and persons provided an early measure of the extent of a local problem. Elimination of visible smoke became the prime objective of most early air pollution control efforts and considerable success has been achieved in many metropolitan areas.

Now it has been made clear that smoke abatement is but one of many facets of the problem. Some very large urban areas which have never developed a smoke problem have, nevertheless, become the best known areas for the occurrence of irritating and damaging smogs, and as a consequence have embarked on major research and control programs aimed at factors other than smoke. Changes in types of fuel, development of motor transport, the enormous diversity of industrial, household, and agricultural contributions to the atmosphere, and the magnitudes of present day human activities seem to demand that the air supply be examined closely. What is it carrying? What is its capacity to receive and disperse such materials? What amounts of various pollutants can be tolerated continuously? What is the fate of substances discharged into the air? What measures for control are practicable, necessary, or desirable?

Concurrently with the changing character of the community air pollution problem there has appeared a significant trend in the technological attitudes respecting the complexities of air pollution problems.

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Whereas twenty-five years ago the few articles published on air pollution were related almost solely to "smoke," currently a major portion of the technical literature is concerned with the complexities of air sampling, the identification of pollutants, the chemical interactions among them, their effects on health, economic losses induced by them, and procedures for their control.

The necessity for extensive, discriminating research to improve the status of knowledge concerning air pollution is now widely recognized. A recent survey of air pollution control activities in the various States revealed a practical unanimity of opinion as to the need for new and more exact information. Suggestions from the more than forty States returning comments varied from generalities to recommendations of specific research objectives such as: the improvement of sampling methods, the development of analytical procedures, the evaluation of techniques and instruments, surveys of characteristics, extent and variations in air pollutants, determination of the effects of pollutants on health and on economic interests, and the evaluation and development of control procedures.

In addition to the comments elicited from the States, the Association of State and Territorial Health Officers has officially called to the attention of the Public Health Service the need for intensification of research efforts relating to air pollution and its effects upon health. In its traditional role of supplementing the activities of State and local health agencies, the Service has made a start toward complying with these requests.

Until the present fiscal year the Public Health Service has had no specific allocation of funds for air pollution studies. Heretofore such research has been incidental to other specifically supported activities - principally in relation to industrial hygiene as in the case of the Donora incident. For the current fiscal year approximately $180,000 is available for the support of air pollution studies at the Robert A. Taft Sanitary Engineering Center in Cincinnati. Certain activities are already well under way, and the general plan of operations has been developed. It is proposed, now, to outline briefly the objectives and limitations of studies presently in progress, and those currently being activated.

More than a year ago, three exploratory projects were initiated at the Center. These were calculated to provide a program planning nucleus, to indoctrinate investigators in the nature and complexities of the air pollution problem, and to furnish certain factual information essential to the prosecution of subsequent research.

Probably the most widely reported of these three preliminary activities has been the so-called nation-wide sampling program. There has been some misunderstanding of its purposes and therefore, occasional criticism of it. Therefore, a brief delineation of the plan, its operation, objectives and limitations may be of interest.

Knowledge is being sought as to the magnitudes and ranges of variation of particulate material in the air over a group of cities selected somewhat arbitrarily for diversity in industrial activity,

type of fuel consumed, topography, meteorology, refuse disposal practice and other factors believed to be related to the pollution problem. Because of the lack of practicable sampling and analytical methods for volatile organics and gases, and the immediate lack of funds, these two important groups of substances were temporarily omitted from the study.

The list of urban areas included has grown rapidly until it now includes about thirty cities scattered throughout the United States and Alaska. Very soon an additional ten regions will be added. In each area at least two sampling sites have been selected by or with the help of the local control agency and at each of these the total particulate load has been taken from about 2,000 cubic meters of air during a 24-hour period approximately once a week. The samplers, especially developed glass fiber filter media, and other sampling paraphernalia are supplied from the Sanitary Engineering Center, while actual collection is being accomplished through the enthusiastic and effective collaboration of municipal and State officers. Wherever possible, additional sampling pertinent to immediate local problems has been added to the regular schedule; in several cities the number of sampling sites is being increased as is the frequency of sampling.

After collection of the particulate load, all samples are shipped to Cincinnati for analysis. Immediate determination is made of the total particulate load per unit volume, the amount of acetone soluble organic material, the level of radioactivity, and the amount

of ninhydrin reactive substances as an index of potential allergenic content. In addition, the Kettering Laboratories of the University of Cincinnati have voluntarily contributed detailed analyses for metals and certain inorganic radicals.

The acetone soluble fractions of the airborne particles present complex analytical problems. Efforts at group and specific identification are being made spectrographically, chromatographically, and by more conventional chemical procedures.

Each sample received is accompanied by such pertinent meteorological data as is available for use in subsequent correlations. In addition, detailed weather data are being supplied for each area by the Weather Bureau.

It is important to understand that the sampling sites are always chosen to avoid the immediate impact of any single local source of pollution; rather, an effort is made to obtain air reasonably representative of the mixture constantly present over the central city area and at a contiguous suburban or rural point. Experience has already indicated that variations between points in a given city are relatively minor as compared to simultaneous variations at all points. While the study of particulate loadings in most of the cities has been in progress too short a time to permit definitive correlations, comparisons, or conclusions, there are certain well established trends which can be used effectively in planning an air pollution research program.

In terms of total load of collectible particles there is a range of approximately ten-fold in the average annual concentration from the cleanest to the dirtiest city. Among the cities having a high average loading (in excess of 200 micrograms per cubic meter) two classes are apparent; one in which the day to day variation is small, leading to a high level of continuous population exposure, and one in which extremely large increases occur in irregular episodes related to meteorological factors. In one area a maximal 24-hour load of 3,112 micrograms per cubic meter was recorded. These very high levels have not been observed in cities currently believed to be troubled by air pollution.

The organic fraction of the particulate matter appears to be a far more accurate index of the contribution of human activity than is the total load which is often patently of exotic natural origin. Acetone soluble materials have a distinctly different city to city distribution. Infrared spectrograms of these substances appear to be reasonable fingerprints of the particular air supply and suggest that indices of man-made pollution should be sought within this difficult group. A great many toxic substances have been identified in the organic fraction by various investigators, although we have no knowledge of their possible effects at very low levels under conditions of continuous exposure. It is of interest that benzpyrenes, recognized carcinogens, have been found in measurable quantities in many of the samples collected during recent months.

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The distribution of ninhydrin reactive materials, which may be classed as potential allergens, has proved surprising and indicates an area for intensive future investigation. It was expected that these substances would be most prominent during seasons of pollen release and in areas most likely to be influenced by vegetation cycles. This is clearly not the case. For the greater part of the areas included in this study, ninhydrin reactive substances have remained at a constant low level throughout the year. However, a few large centers of population have shown consistently high and frequently very high, loadings of "potential allergens." The causes of this phenomena are not known and additional study is indicated. One speculation on which future investigation will be based relates the high levels of amino-nitrogen to local waste disposal practices. It so happens that many of the cities showing large amounts of these substances depend on household and apartment house incineration for disposition of a portion of their garbage and solid wastes. Inefficient combustion, resulting in incomplete pyrolysis, could produce the kinds of airborne substances being measured by the ninhydrin method.

Correlations of data from the many hundreds of samples being processed at present should result in a very solid bulwark of base line data on magnitudes, ranges of variation, community related differences in composition, influences of elevation, weather, type of industrial or agricultural complex, heating and general sanitation practices and other variables. From this information, and the guidance obtainable from many persons who have been concerned with air pollution problems

in local areas, will emerge during the next several months, a program of research pointed toward the understanding and solution of experimentally defined problems.

A second exploratory activity in the general area of air pollution has been undertaken by Drs. Lewis and Harris during recent months. This involves an attempt at statistical correlation between available mortality data from a large metropolitan area and measured meteorological and pollutional data covering the same period of years. There is reason to suspect, judging from the evidence of the Donora and London episodes, that the effects of prolonged periods of air pollution related to atmospheric inversions are felt immediately and to some extent reflected in the vital statistics of the community within a matter of days afterward. Whether or not statistical evidence can be found sufficiently conclusive to confirm this suspicion is a moot question. Nevertheless, if such correlations could be established, it is apparent that this type of index to the effect of air pollution on health would be of great value in determining levels of pollution tolerable by man.

A third exploratory operation has been initiated, looking toward assembly of information relative to local evaluations of air pollution problems, and local efforts at investigation and control. This will be a continuing effort, but has already revealed a wholly unsuspected volume of concern and uncoordinated activity respecting the developing problem.

At the beginning of the current fiscal year the Congress made available to the Center the first funds ever specifically earmarked by

the Federal Government for community air pollution control investigation activities. Consequent to this an initial program has been developed and is in process of activation. In general terms this will include five types of activity:

1. It is proposed to expand the exploratory sampling network. Expansion will be toward inclusion of more problem areas as well as toward the intensification of study in areas already activated.

2. It is proposed to begin work immediately on the evaluation, and where necessary, on the development of sampling equipment and analytical procedures for gases and volatile substances. As soon as satisfactory and practicable procedures are available, study of these components of the atmosphere in the network cities will be started.

3. A beginning will be made this year on the study of the physiological effects of air pollutants with a view toward the ultimate establishment of control standards. Almost nothing is known at present as to the toleration limits of most air pollutants, either singly or in combination under conditions of continuous exposure.

4. The exploratory attempt at correlations between pollutional loadings and mortality data will be extended to include several cities from which appropriate data can be obtained.

5. An overall study of community control patterns related to the air pollution problem will be initiated. The objectives will include determination of necessary survey patterns, procedures for obtaining unified support for programs in regions involving several municipalities, counties or States, probable legislative requirements and such other guideline data as may be of value to local agencies in the establishment of an air pollution control program. In order to accomplish this task, one or more local problem areas will be used as guinea pigs for the development and testing of techniques. In addition, this group will begin the assembly of certain technical guides respecting control of air pollution as related to specific types of human activity as, for example, refuse incineration and combustion of automotive fuels. This program is not complete, but it is felt that it offers an approach to the most significant contributions the Public Health Service can make toward guidance and technical assistance to State and local control agencies within the framework of existing legislative authority and financial support.

The air we breathe has assumed its proper role in the program of the Sanitary Engineering Center and of the Public Health Service as a whole. It now stands parallel with water and the other essential components of the environment as a recognized program entity. There are serious problems of staffing for the proper development of this

new activity in the face of competition for scientifically trained personnel throughout the Nation, but substantial progress is being made toward recruitment.

The pollution of our atmosphere has developed into a problem of such magnitude that no one locality and for that matter, no national center, can be expected to make significant progress in it without extensive coordination and collaboration with other groups. To effect this combination of effort, means will hereafter be sought for the establishment of guidance on a nation-wide basis. The exact form of this guidance is still subject to determination and open to suggestion.